Discussion of Watershed Goals




What are your water quality goals?

- What is a healthy watershed?
- Can you name specific attributes?
- Are there ways to measure them?
- How can we measure them?

United States Code, Title 33

Sec. 1251. Congressional declaration of goals and policy

- (a) Restoration and maintenance of chemical, physical and biological integrity of Nation's waters; national goals for achievement of objective

The objective of this chapter is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. In order to achieve this objective it is hereby declared that, consistent with the provisions of this chapter -

- (1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985;
- (2) it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983;
- (3) it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited;
- (4) it is the national policy that Federal financial assistance be provided to construct publicly owned waste treatment works;
- (5) it is the national policy that areawide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each State;
- (6) it is the national policy that a major research and demonstration effort be made to develop technology necessary to eliminate the discharge of pollutants into the navigable waters, waters of the contiguous zone, and the oceans; and
- (7) it is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this chapter to be met through the control of both point and nonpoint sources of pollution.

Clean Water Act

CWA: Part I

- Focus on point source (PS) discharges to surface waters, through NPDES permitting
- Limits apply regardless of condition of receiving water, or relative contribution from the source
- Pollutant levels in discharges determined by technical/economic feasibility
- Same limits placed on all PS within each industrial grouping (50 categories/plus subcategories)
  - Generally, municipal sewage plants must achieve discharge equal to "secondary treatment"

NPDES permitting under Sec. 402

- Illegal for point source (pipe, ditch, channel, tunnel, vessel, rolling stock, or other manmade conveyance) to discharge pollutants to surface waters without a permit
- Permit is a license granting permission to discharge
  - **Not a right: permit is revocable "for cause" (e.g., non-compliance)**

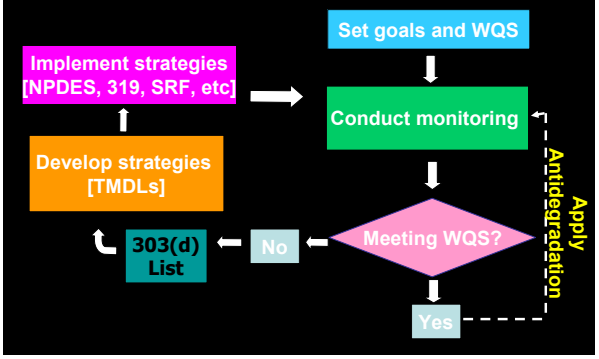
NPDES Program: Coverage

- Industrial and municipal wastewater
- Industrial, urban, and construction-related storm water runoff
- Concentrated animal feeding operations (CAFOs)
- Active, inactive, and some abandoned mines
- Discharges from RCRA remedial action activity meeting point source definition

Effluent (discharge) limits

- "Technology-based" end-of-pipe (concentration/mass)
  - BAT, NSPS, PSES, secondary treatment, etc.
  - Spelled out in EPA regulation packages (effluent guidelines)
  - Use best professional judgment (BPJ) if no EPA regulations
- Water quality-based (linked to TMDLs)
  - Only where tech-based controls are insufficient to meet WQS
    - Back-calculated from numeric WQC: pollutant concentrations in discharge
    - Derived from narrative criteria: whole effluent toxicity testing

CWA: Part II, WQ-Based



Water Quality Standards

- State's yardstick to measure health of waters
- Three key elements of WQSs:
  - Designated uses
  - Water quality criteria
  - Antidegradation provisions

WQS: Process

- WQS established by states and tribes
- EPA must review/approve prior to becoming effective
- If EPA disapproves a state or tribe WQS and state or tribe doesn't revise it, EPA promulgates a WQS
- Public review and comment at state, tribal, and federal levels (if EPA promulgates)
- States must review their WQS every three years and submit them to EPA

Indian Tribes and WQS/CWA

- Section 518 of the CWA: Under specific circumstances EPA is to "treat tribes as states" with regard to CWA programs, including:
  - Water quality standards
  - Water quality monitoring and reporting
  - TMDLs
  - NPDES
  - Various CWA grant progra

WQS: Key Definitions

- **Designated use** - Expression in WQS of a use of a specific waterbody that should be attained, regardless of current use
- **Existing use** - Any use that has been attained or has occurred in a waterbody since November 1975
- **Downgrading** - Changing a designated use from a "higher" (more sensitive) use to a "lower" one
- **Upgrading** - Changing the designated use from a "lower" to a "higher" one

WQS: Designating Waterbodies

The General Rules

- Must designate all "existing" uses
- Fishable/swimmable required, with rare exceptions
- "Waste transport" not OK
- Multiple uses OK; "most sensitive use reigns"
- Can consider economic factors
- Must not preclude attainment of downstream WQS

Example Use Designation

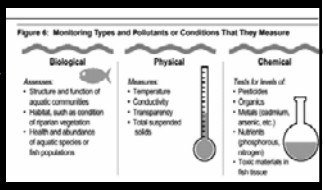
- Aquatic life support – warmwater & coldwater aquatic habitat
- Primary contact recreation – swimming
- Secondary contact recreation – boating and fishing
- Fish consumption – eating fish
- Drinking water – domestic water supply






Water Quality Criteria

- Consistent scientifically with protecting all designated uses (DUs)
- Basic types of criteria
  - Narrative/numeric
  - Water column/sediment/ fish tissue
- Categories of criteria
  - Aquatic life
    - Pollutant-specific/aquatic community indices
  - Human health (drinking/fish consumption)
  - Wildlife (semiaquatic/food chain effects)



WQS: Numeric Criteria

- **Parameter-specific: DO, temp., turbidity, N, P, Cu, dioxin, etc.**
  - Level/concentration: 1 mg/L, 5 mg/kg
  - Duration:
    - Acute: instantaneous, 1-hour, 1-day
    - Chronic: 4-day, 7-day, 30-day
  - Recurrence interval: 1 year, 3 years

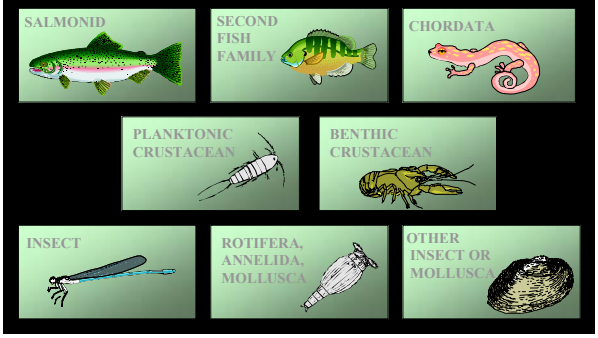
WQC: Warmwater Aquatic Life

Parameter	Value	Units
Dissolved Oxygen	>4.0	milligrams/liter
pH	6-9	Standard Units
Un-ionized Amonia-N	0.05	mg/l
Fecal Coliform	400	Colonies/100ml
Temp	30	Degrees C

Range of US EPA Nutrient Criteria for 17 Freshwater Ecoregions

Nutrient	Criteria
Lakes and Reservoirs	
Total phosphorus	0.008–0.037 mg/l
Total nitrogen	0.100–0.780 mg/l, with one Ecoregion at 1.27 mg/l
Chlorophyll a	1.90–12.35 ug/l
Rivers and Streams	
Total phosphorus	0.010–0.067 mg/l, with one Ecoregion at 0.128 mg/l
Total nitrogen	0.120–0.900 mg/l, with one Ecoregion at 2.18 mg/l
Chlorophyll a	1.08–3.75 ug/l
Turbidity	1.30–7.83 FTU/NTU, with one Ecoregion at 17.50

Biological Criteria: Minimum data set for freshwater WQC derivation



WQS: Narrative Criteria

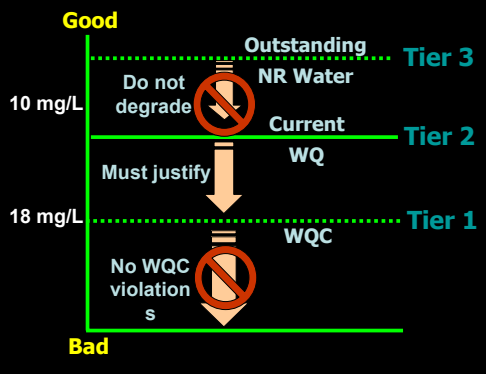
- Waters must be "free from"
  - Putrescent or otherwise objectionable bottom deposits
  - Oil, scum, and floating debris in amounts that are unsightly
  - Nuisance levels of odor, color, or other conditions
  - Undesirable or nuisance aquatic life
  - Substances in amounts toxic to humans or aquatic life

Usually apply to all waters, regardless of use designation

WQS: Antidegradation

- Purpose: Prevent deterioration of existing levels of good water quality
- Two basic rules apply to all high quality waters
- More stringent rules apply to specially-designated waters

Antidegradation Overview



Total Maximum Daily Loads (TMDLs)

- Amount of a specific pollutant that a waterbody can receive, assimilate, and still meet water quality standards
- States and tribes are required to develop TMDLs for waters on their 303(d) lists
- TMDLs are approved or disapproved by EPA; if disapproved, EPA develops the TMDL

TMDL Definition

$$TMDL = \Sigma WLA_i + \Sigma LA_i + MOS$$

ΣWLA_i: Sum of waste load allocations (point sources)

ΣLA_i: Sum of load allocations (nonpoint sources)

MOS: Margin of Safety

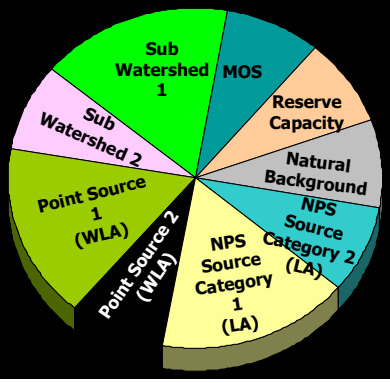
- Extra measure of protection due to uncertainty
- Can be explicit (e.g., 10%) or implicit (safety factors and assumptions in modeling, etc.)

TMDL: Allocations

- Each point source with individual NPDES permit receives a wasteload allocation (WLA)
- Point sources covered under general permits can also get a wasteload allocation (WLA)
- Individual sources, categories, subcategories of nonpoint sources are represented by a load allocation (LA)

No EPA rules on how to allocate

TMDL Allocation



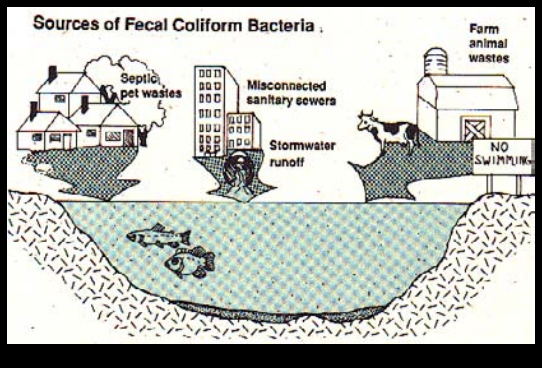
Prioritizing watersheds & issues

- Prioritization can be:
  - by geographic area (watersh
  - by issue clusters (bundles)
    - sediment from logging
    - stream buffer encroachment
- Implementation guided by:
  - need (level of degradation)
  - ability (available resources)
  - desire (willing local partners)

Tribal NPS and Watershed Issues

Identifying Problems and Priorities

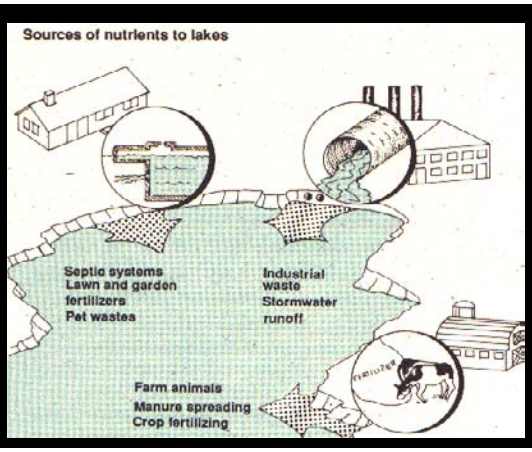
Common NPS pollutants: bacteria



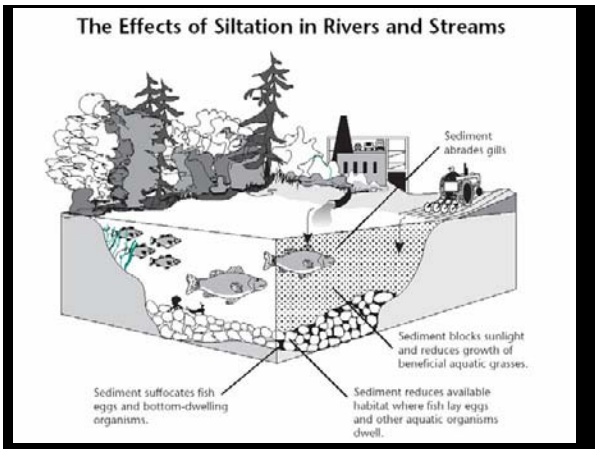
Nutrients

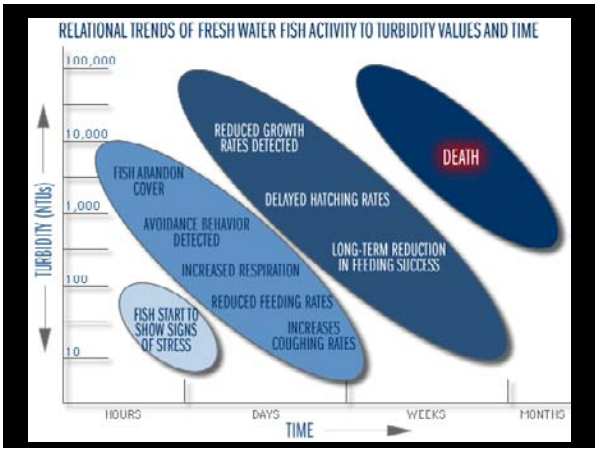
Most inland fresh waters will "bloom" with algae when phosphorus is added.

Bacteria that decompose algae suck dissolved oxygen out of the water, and can lead to fish kills



Common NPS pollutants: sediment



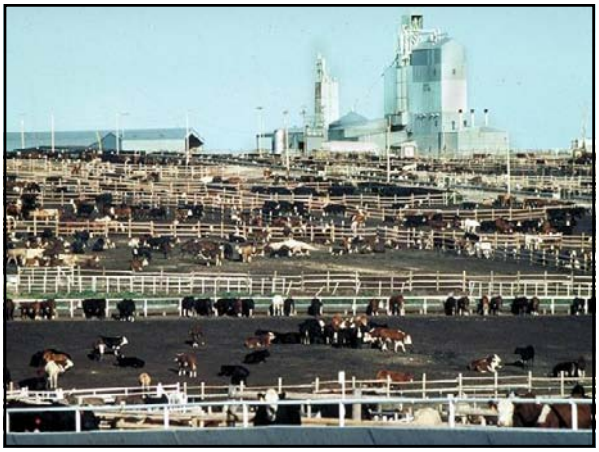


Typical erosion rates (averages)

- Forest land: 1 ton/acre/year
- Farm land: 8 to 20+ tons/acre/year
- Construction sites: 100+ tons/acre/year

Cropland impacts

- Bare soil exposed and eroding into streams
- Compacted soil increases runoff rates
- Organic matter loss further decreases infiltration
- Irrigation can deplete surface & groundwater
- Common pollutants:
  - Sediment
  - Nutrients
  - Pesticides
  - Herbicides



Livestock production impacts

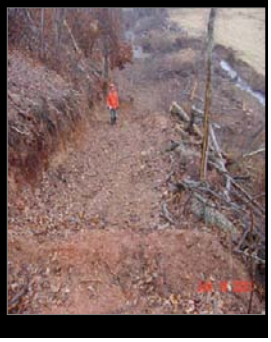
- Rapid runoff where animals are confined
- Animal waste loads are increased
- Carcass disposal can add to impacts
- Loss of vegetation along streams (pasture/range)
- Common pollutants:
  - Nutrients
  - Sediment
  - Bacteria
  - Other animal pathogens

Agricultural impacts overall

- 59% of assessed rivers and streams in the U.S. are impaired from agricultural activities.
- The primary pollutants are nutrients, sediment, animal wastes, salts, and pesticides.
- Ag production - like urbanization - can cause severe impacts to stream channels, leading to vegetation loss, bank erosion, and massive sedimentation of receiving waters.

Timber harvest impacts

- Sediment runoff from haul roads and skid trails
- Loss of forest duff & topsoil
- Soil compaction, reduced infiltration
- Loss of streamside vegetation
  - Reduced woody debris inputs
  - Reduced shading
  - Increased temperature

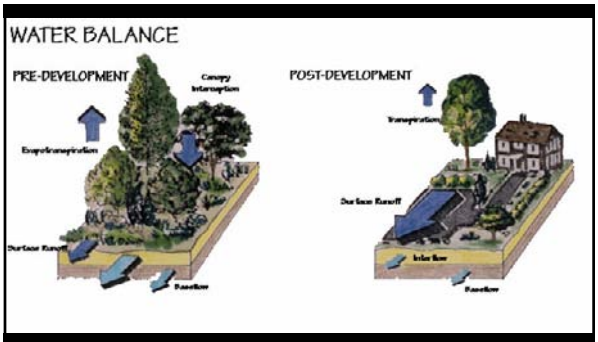


Urban development impacts

- Pavement, roofs, sidewalks, and other hard surfaces dramatically increase runoff and decrease soil infiltration
- Runoff from urban areas contains:
  - Oil and grease (from roads & parking lots)
  - Pesticides, fertilizers, nutrients (from lawns/gardens)
  - Sediment (mostly from construction sites)
  - Heat (from hard surfaces)
  - Bacteria (from pet wastes, septic systems)
  - Trash (from roadways, parking lots,

Urban pollutants & their sources

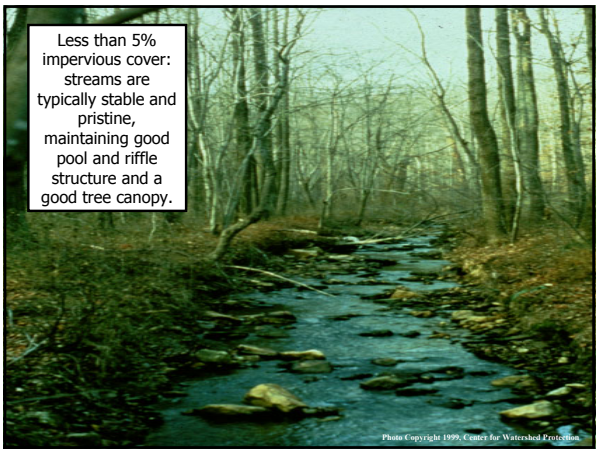
Pollutant Category	Probable Sources
Nutrients	• Atmospheric deposition and washout • Septic system effluent through groundwater or system overflows • Lawn fertilization
Pathogens	• Urban wildlife and domestic pets • Wastewater discharges
Sediment	• Channel erosion from increased storm water runoff due to impervious surfaces • Exposed soils at construction sites • Urban runoff (e.g. tire wear from city streets)
Industrial Chemicals and Pesticides	• Intermittent pulse exposures, often weather-related • Runoff and groundwater contamination from land-based sources, including waste disposal sites



Development and increased impervious cover (roads, roofs, parking lots, etc.) disrupts natural water balance.

Water runoff is dramatically increased in the post-development setting; infiltration is decreased.

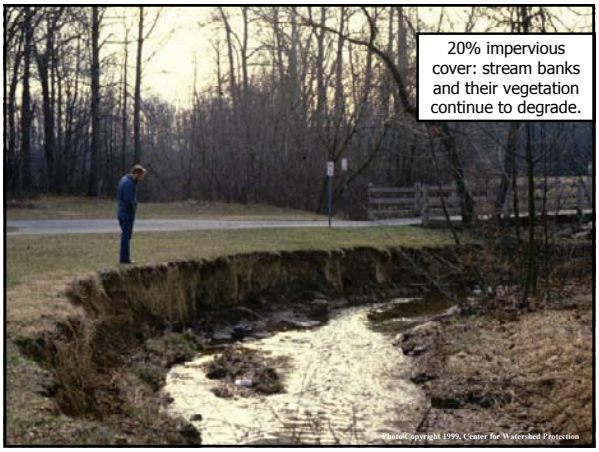
Streams degrade slowly, over time . . .


Less than 5% impervious cover: streams are typically stable and pristine, maintaining good pool and riffle structure and a good tree canopy.
Photo Copyright 1999, Center for Watershed Protection


8-10% impervious cover: stream is still relatively stable, but signs of streambank erosion are apparent.
Photo Copyright 1999, Center for Watershed Protection


10% impervious cover: stream begins to widen as it eats away the banks; trees begin leaning and falling into the stream; sediment from the banks piles up in the channel.
Photo Copyright 1999, Center for Watershed Protection


20% impervious cover: more bank erosion, more sediment build-up.
Photo Copyright 1999, Center for Watershed Protection


20% impervious cover: stream banks and their vegetation continue to degrade.
Photo Copyright 1999, Center for Watershed Protection

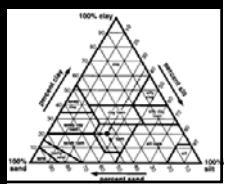

30% impervious cover: sewer lines are exposed as the stream widens further to carry increased runoff.
Photo Copyright 1999, Center for Watershed Protection

Other impacts from the land

- Septic systems
  - Bacteria, nutrients
- Old waste sites
  - Can leach contaminants
- Illegal dumping
  - Used motor oil, etc.
- Lawn & garden products
  - Fertilizers, pesticides, herbicides

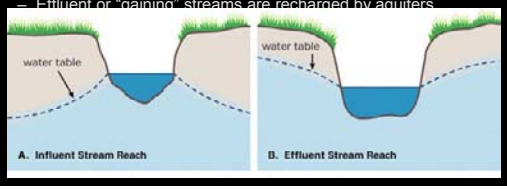
Soils and watersheds

- Soils are a key factor governing watershed formation
  - Erosion potential
  - Runoff rates
  - Vegetation types and densities
- Permeability
  - Sands and gravels: High infiltration rates
  - Silt loam, sandy clay loam: Moderate infiltration rates
  - Clays: Low infiltration rate; high runoff
- Soils also affect human aspects of watershed and land use factors:
  - Agriculture
  - Development
  - Septic systems

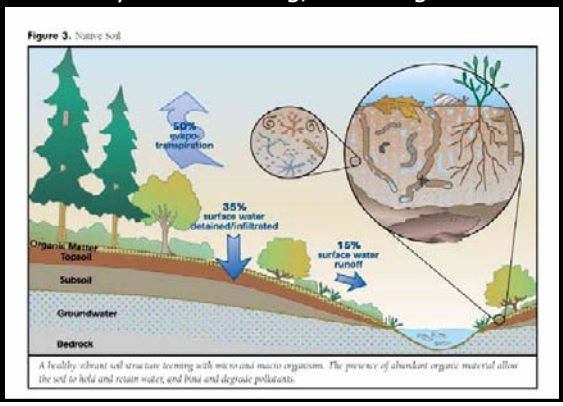


Why worry about soils?

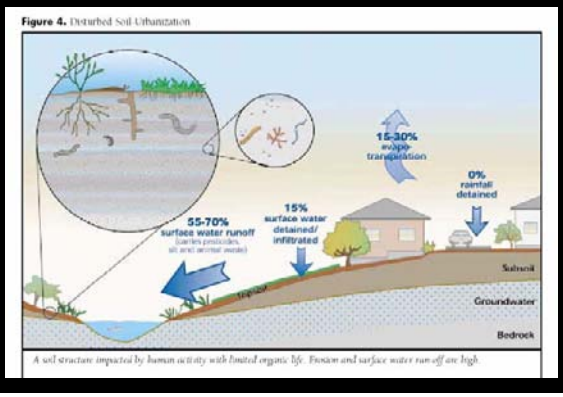
- Bare soil erodes quickly, fouling waterways
  - Sediment is a "Top 3" pollutant nationwide
  - Soils can act as a "carrier" for nutrients, pesticides, herbicides
- Compacted "dead" soils have high runoff rates
  - Some ag & residential lands shed water almost as fast as pavement
- Ground water relationships
  - Influent or "losing" streams discharge to aquifers
  - Effluent or "gaining" streams are recharged by aquifers



Healthy soils are living, breathing entities



Impacts of soil compaction



Soil degradation

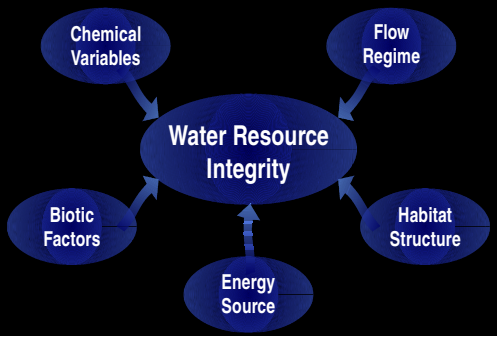
- Erosion
- Organic matter loss
- Acidification
- Reduced biological activity
- Nutrient depletion
- Compaction
- Salinization
- Water-logging
- Chemical toxicity

Measuring watershed health

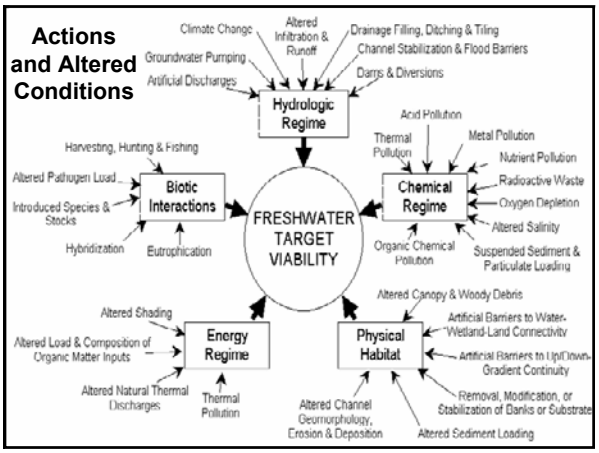
Measurements can be taken:

- In the stream, river, lake, or wetland
- Along the bank area
- Within the uplands regions
  - Agricultural areas
  - Logging and mining sites
  - Towns and cities

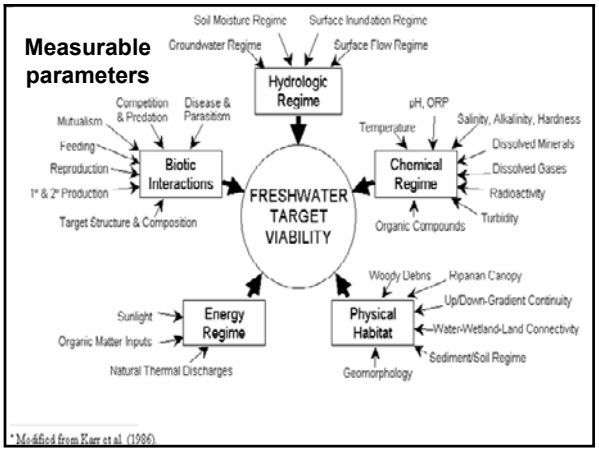
Primary factors influencing water quality



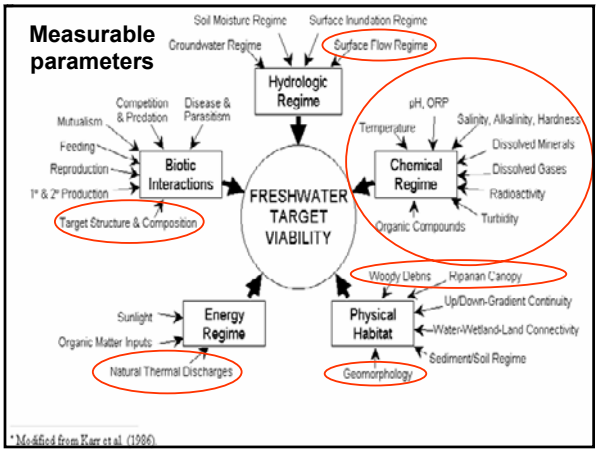
Actions and Altered Conditions



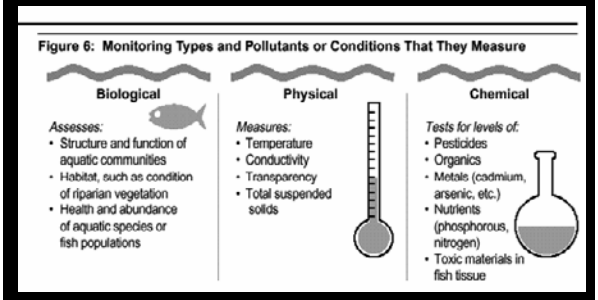
Measurable parameters



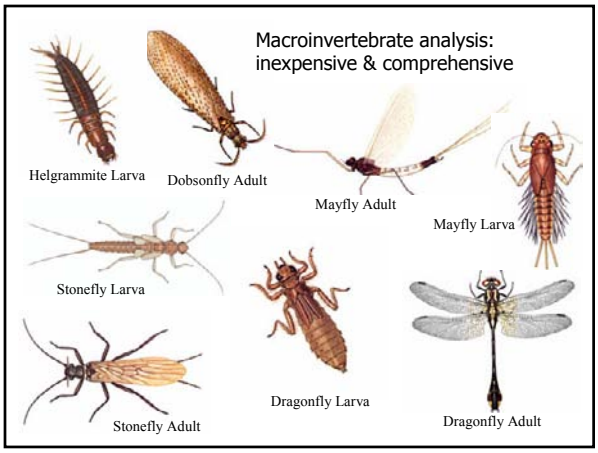
Measurable parameters



Physical, chemical, and biological factors are most often measured, but flow and energy (mostly sunlight) can be important considerations



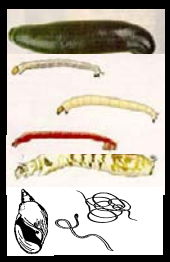
Measurable indicators in the stream, river, lake, or wetland



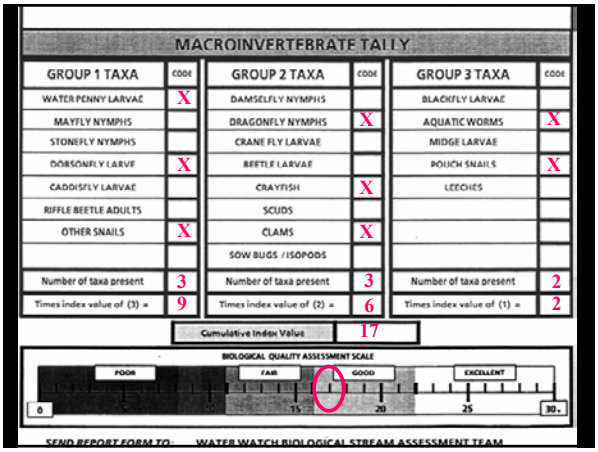
Organisms can be categorized according to their tolerance for pollution or poor habitat conditions

Good

Mid Range



Poor



MACROINVERTEBRATE TALLY

GROUP 1 TAXA	CODE	GROUP 2 TAXA	CODE	GROUP 3 TAXA	CODE
WATER PENNY LARVAE	X	DAMSELFLY NYMPHS		BLACKFLY LARVAE	
MAYFLY NYMPHS		DRAGONFLY NYMPHS	X	AQUATIC WORMS	X
STONEFLY NYMPHS		CRANE FLY LARVAE		MIDGE LARVAE	
DOBSONFLY LARVE	X	BEETLE LARVAE		POUCH SNAILS	X
CADDISFLY LARVAE		CRAYFISH	X	LEECHES	
RIFFLE BEETLE ADULTS		SCUDS			
OTHER SNAILS	X	CLAMS	X		
		SOW BUGS /ISOPODS			
Number of taxa present	3	Number of taxa present	3	Number of taxa present	2
Times index value of (3) =	9	Times index value of (2) =	6	Times index value of (1) =	2

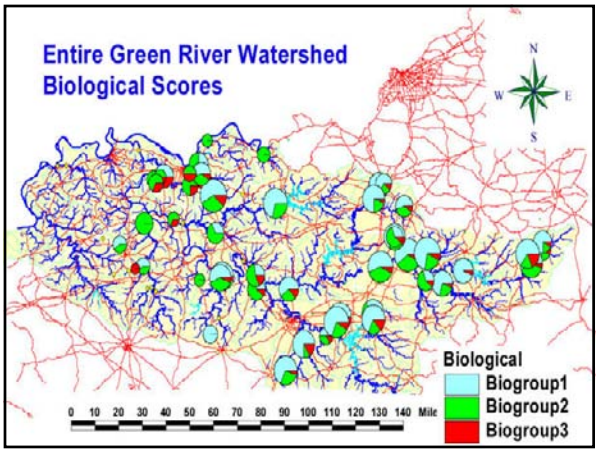
Cumulative Index Value: 17

BIOLOGICAL QUALITY ASSESSMENT SCALE

POOR | FAIR | GOOD | EXCELLENT

0 15 20 25 30

SEND REPORT FORM TO: WATER WATCH BIOLOGICAL STREAM ASSESSMENT TEAM



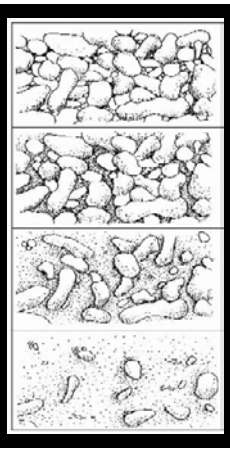
Moving from the biological to the physical: siltation and other structural (physical) aspects of the stream affects habitat

Optimal

Suboptimal

Marginal

Poor

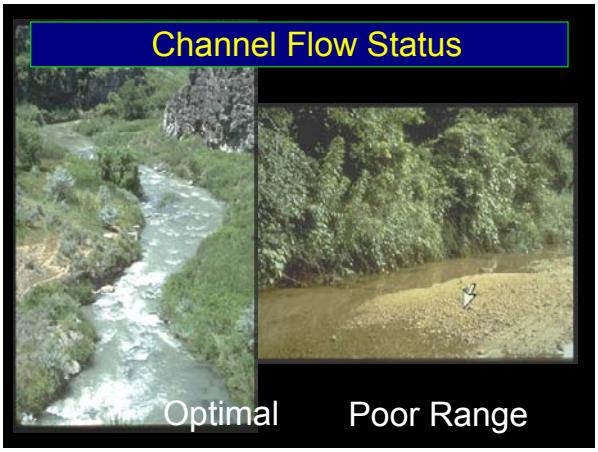


Stream Bottom Structure & Critter Cover

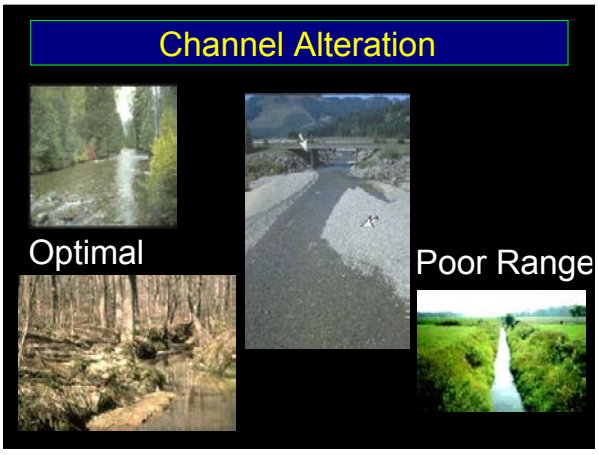
Embeddedness

Sediment Deposition

Channel Flow Status



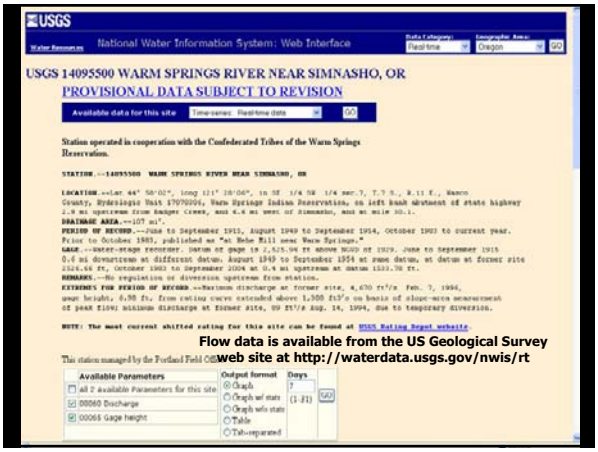
Channel Alteration



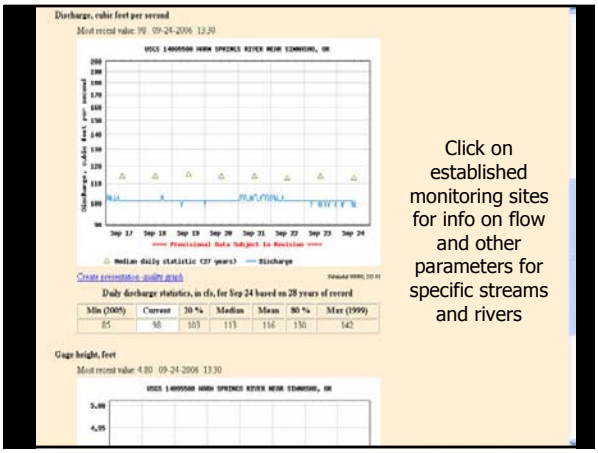
HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE _____ TIME _____ AM PM / REASON FOR SURVEY

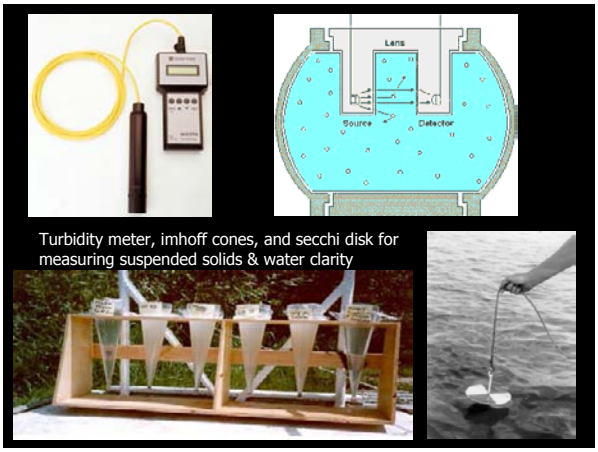
	Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
Parameters to be evaluated in sampling reach	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0



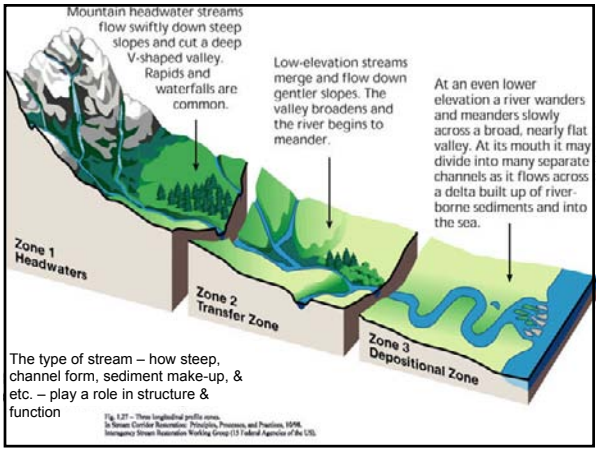
Flow data is available from the US Geological Survey web site at http://waterdata.usgs.gov/nwis/rt



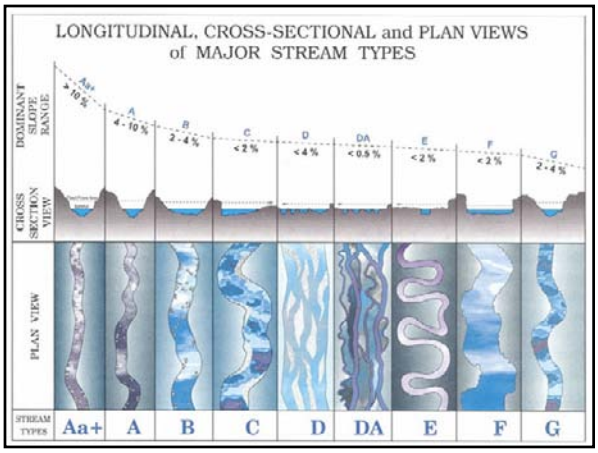
Click on established monitoring sites for info on flow and other parameters for specific streams and rivers



Turbidity meter, imhoff cones, and secchi disk for measuring suspended solids & water clarity



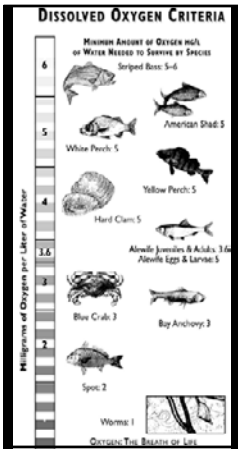
The type of stream – how steep, channel form, sediment make-up, & etc. – play a role in structure & function



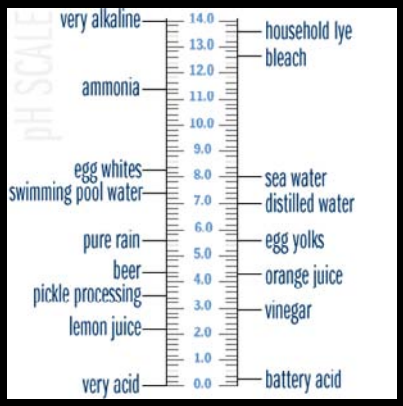
Chemical and other lab-based tests:

More costly, lots of possible pollutants to look for

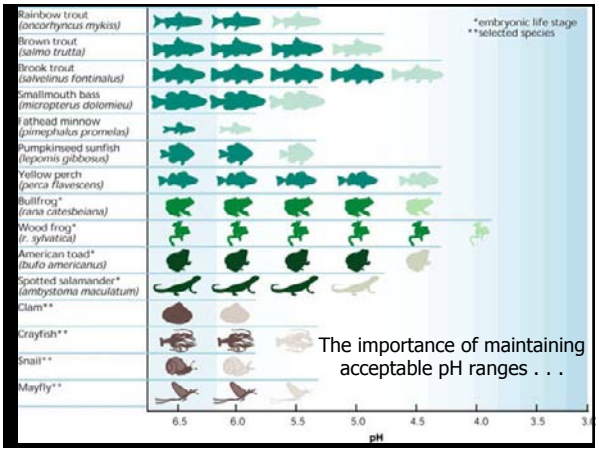
Floating oil, grease, and gasoline can be checked for easily . . . (Cuyahoga River fire aftermath: July, 1969)



Dissolved oxygen: a key water quality measure

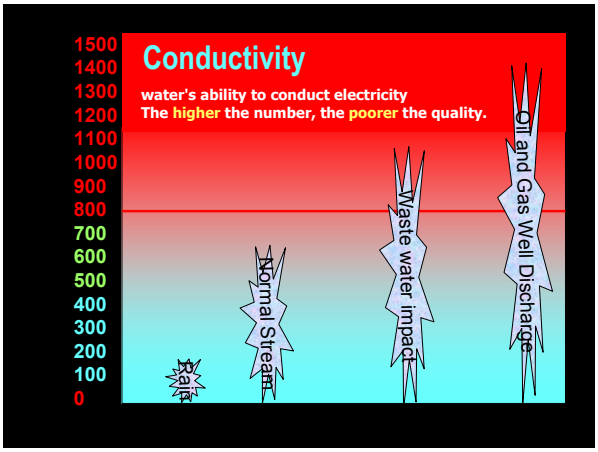


pH: a measure of hydrogen ion strength indicating acidity or alkalinity



The importance of maintaining acceptable pH ranges . . .

Nutrients: phosphorus & nitrogen

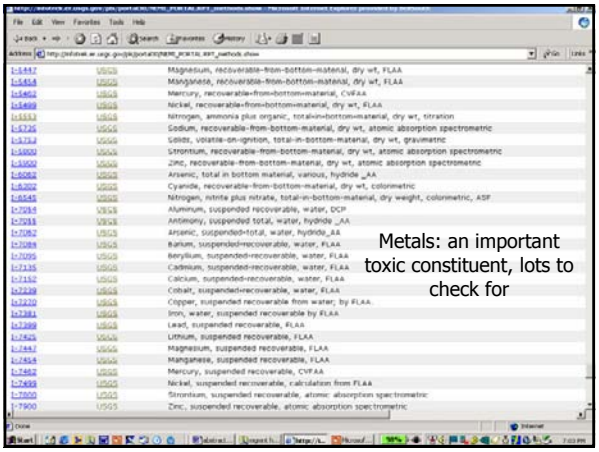


Conductivity meter (and you get a thermometer!)

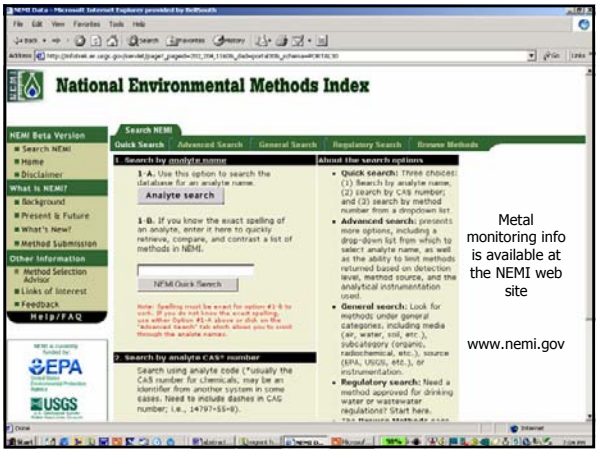
Temperature: different ranges for different biological functions

Species	Max. Weekly Average Temp. for Growth (juveniles)	Max. Temp. for Survival of Short Exposure (juveniles)	Max. Weekly Average Temp. for Spawning[a]	Max. Temp. for Embryo Spawning[b]
Atlantic salmon	68°F	73°F	41°F	52°F
Bluegill	90°F	95°F	77°F	93°F
Brook trout	66°F	75°F	48°F	55°F
Common carp			70°F	91°F
Channel catfish	90°F	95°F	61°F	84°F
Largemouth bass	90°F	93°F	70°F	81°F
Rainbow trout	66°F	75°F	48°F	55°F
Smallmouth bass	84°F		63°F	73°F
Sockeye salmon	64°F	72°F	50°F	55°F

[a] Optimum or mean of low range of spawning temperatures reported for the species.
[b] Upper temperature for successful incubation and hatching reported for the species.
[c] Upper temperature for spawning.

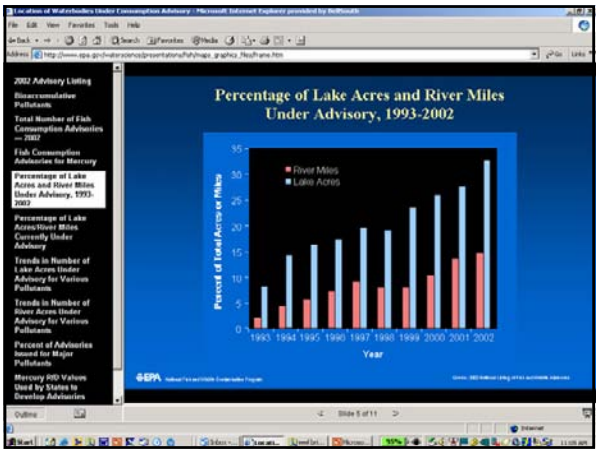


Metals: an important toxic constituent, lots to check for

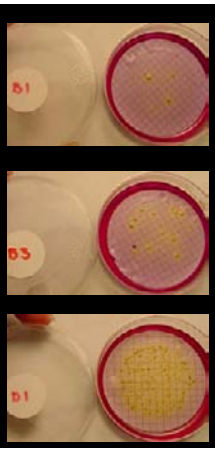


Metal monitoring info is available at the NEMI web site

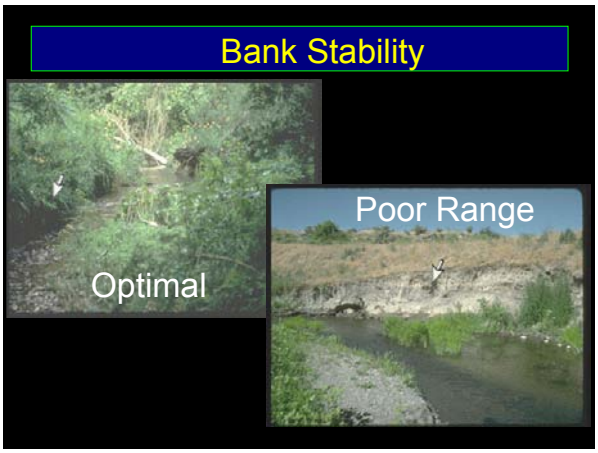
www.nemi.gov

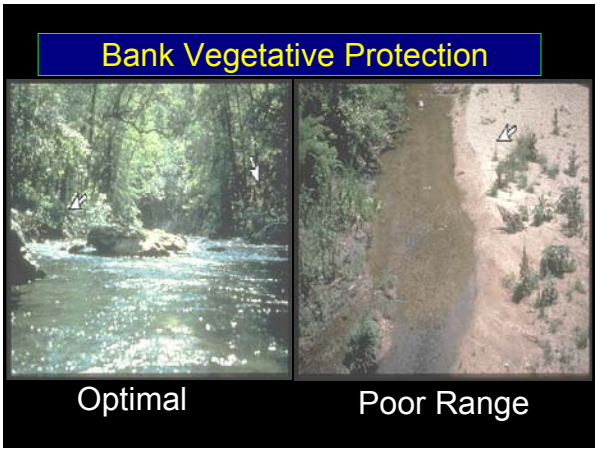


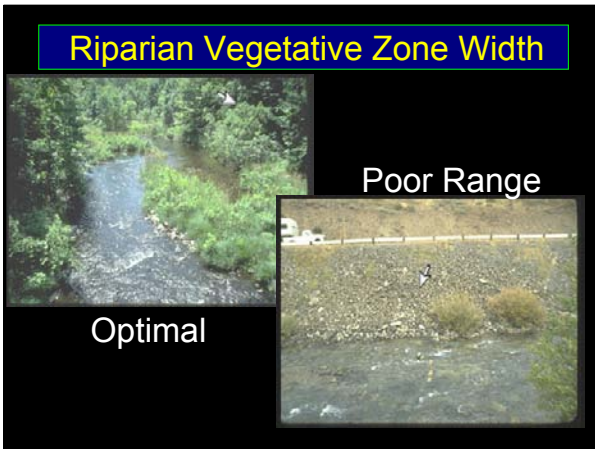
Most programs measure fecal coliform bacteria "colony-forming units" per 100 milliliters of raw water, or E. coli counts



Measurable indicators for assessing conditions along the bank area


Bank Stability
Optimal
Poor Range


Bank Vegetative Protection
Optimal
Poor Range

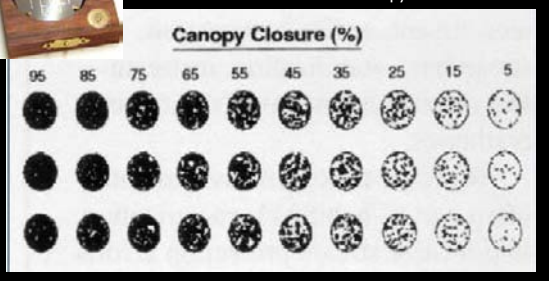

Riparian Vegetative Zone Width
Poor Range
Optimal

8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.			Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.			Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.			Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.		
SCORE ___ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ___ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.			70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.			50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.			Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.		
SCORE ___ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ___ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.			Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.			Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.			Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.		
SCORE ___ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ___ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0

Measuring canopy cover

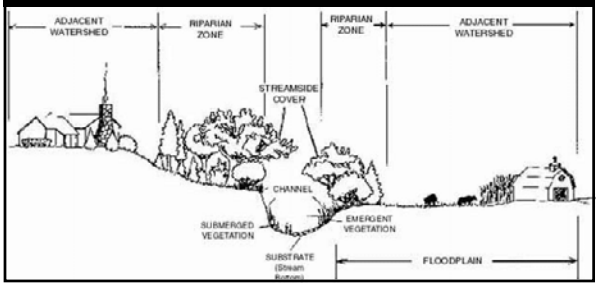
Spherical densiometer in walnut case

Ocular canopy cover estimator

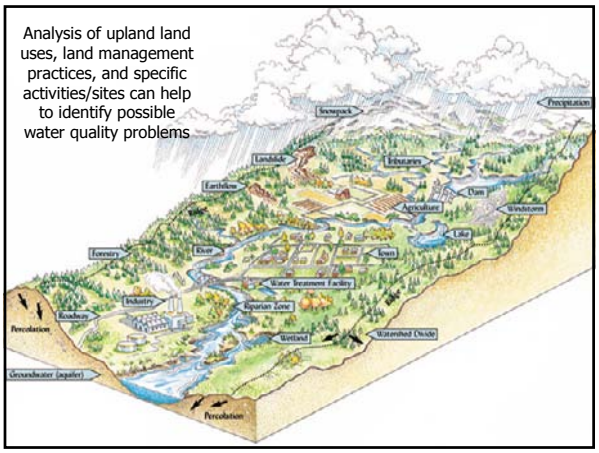


Measuring aspects of the upland regions

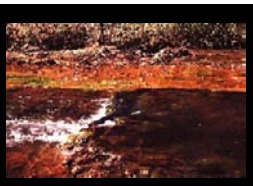
- Agricultural areas
- Logging and mining sites
- Towns and cities
- "Hot" spots
- Commercial strips
- Industrial facilities



Analysis of upland land uses, land management practices, and specific activities/sites can help to identify possible water quality problems



Legacy and/or existing contaminant sources



Summary: types of data needed for holistic assessments

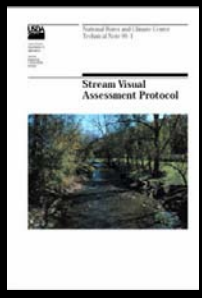
- Chemical
  - DO, pH, nutrients, metals, pesticides
- Physical
  - Flow, temp, turbidity, habitat, pool/riffle
- Biological
  - IBIs, macro inverts, bacteria, riparian cover
- Land uses
  - Urban, suburban, ag, forest, pervious and impervious cover, hotspots
- Potential pollutant sources
  - NPDES, mines, stormwater outfalls, site-specific

Stream Visual Assessment Protocol (NRCS)

One assessment tool provides basic stream health evaluation. Scores are assigned for the following:

Channel condition	Hydrologic alteration
Riparian zone width	Bank stability
Canopy cover	Water appearance
Nutrient enrichment	Manure presence
Salinity	Fish movement barriers
Instream fish cover	Pools and riffles
Invertebrate habitat	Macro invertebrates

http://www.ncg.nrcs.usda.gov/pdf/svapfnl.pdf



Data sources

- Web sites
  - USEPA, USGS
- State agencies
  - DEM, DNR, Mining, Ag
- Local agencies
  - Property valuation office
  - County soil and water conservation
- Environmental/ recreation organizations
  - Volunteer monitoring groups
  - Angler organizations
- Collect your own!